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## ABSTRACT

A project was designed to improve Aboriginal children's performance in mathematics, starting from their earliest introduction to number work. It explored the use of an enriched mathematics environment that minimally conflicts with traditional Aboriginal learning styles. The study was concerned with evaluating the effectiveness of a program intervention in remote Aboriginal schools, based on the results of pre- and post-interviews given to children at eight different schools in Western Australia at the beginning and end of 1989 and 1990. Comparisons were made with data for children at other schools. The data were derived from interviews with young children and provided evidence of their performance in several key areas of early mathematics. Based on the initial results, the schools were categorized into three types ranked in descending order of achievement level: the White middle-class schools, the town Aboriginal and White working class schools, and the remote Aboriginal schools. There was a rather consistent gain in mean achievement scores for the majority of all schools over the course of the first year; hence, existing differences between school types at the beginning of the year were still evident at the end of that year. At this stage, it is difficult to conclude whether the intervention program has improved mathematics achievement for the remote Aboriginal children; yet, at minimum, there is also no evidence of the progressive retardation that describes the prevailing situation where Aboriginal children drop farther behind as they advance through school. (30 references) (Author/JJK)

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## MATHEMATICAL ACHIEVEMENT OF ABORIGINAL CHILDREN

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# Mathematical Achievement of Aboriginal Children

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## Abstract

This paper provides some early results on a project designed to improve Aboriginal children's performance in mathematics, starting from their earliest introduction to number work. It explores the use of an enriched mathematics environment that minimally conflicts with traditional Aboriginal learning styles. The study is concerned with evaluating the effectiveness of a program intervention in remote Aboriginal schools, based on the results of pre- and post-interviews given to children at eight different schools in Western Australia at the beginning and end of 1989 and 1990. Comparison data with those for children at other schools are provided in this paper. The data derive from interviews with young children, and provide evidence on their performance in several key areas of early mathematics. Based on the initial results the schools were categorized into three groups: White middle class; town Aboriginal and working class; and remote Aboriginal. The White middle class schools had the highest performance, followed by the town Aboriginal and White working class schools and the remote Aboriginal schools. There was a rather consistent gain in mean scores for most schools of around four points over the course of the first year so that existing differences between schools at the beginning of the year were still evident at the end of the year. At this stage it is difficult to conclude whether the intervention program has improved mathematics achievement for this group of remote Aboriginal children. There is at least no evidence of 'progressive retardation' which describes the current situation where Aboriginal children fall farther behind as they progress through school.

## Background

One of the most disturbing aspects of the schooling of Aboriginal children in Western Australia is to discover how poorly they perform in mathematics. There is a gross under-representation of Aborigines in mathematics classes in the upper secondary school level in Australian schools and Aborigines perform poorly in mathematics compared with non-Aborigines. Over the period 1981-85 in Western Australia, the overall school retention rate of Aboriginal students from Year 8 to Year 12 was 4% compared with the national average of 35% (NAEC, 1984).

Hunting and Whitely (1983), in a review of research related to mathematics achievement of Aboriginal children, concluded that "European contact is a major factor for success with tests of cognitive ability, suggesting that European-type enrichment of the Aboriginal child's environment will lead to measurable gains in cognitive functioning and in mathematics achievement". Aboriginal children from more traditionally-oriented communities performed poorly on tests of 'classificatory ability' (de Lacey, 1970); 'verbal intelligence and operational thinking' (de Lacey, 1971); 'conservation of quantity, weight, volume, length, area and number' (de Lemos, 1969); 'conservation of quantity and weight, classification, seriation and horizontality' (Seagrim and Lendon, 1980). However, Aboriginal children from more traditionally-oriented communities performed better than 'non-traditional Aboriginal children who, in turn, performed better than 'White Australian' children on tasks requiring visual spatial memorisation strategies (Kearins, 1976 and 1981).

Studies with American Indians show that their achievement is lower than other groups in most content areas. For example, Cheek (1984) reported that "the average mathematical achievement levels of Native American students are extremely low in comparison with students of other ethnic groups" (1984, p1). Brod's (1979) Mississippi study confirmed a conclusion reached by the Senate Subcommittee on Indian Education (1969) ten years earlier: American Indian children typically fall farther and farther behind national norms as they progress through school. This phenomenon has been designated as 'progressive retardation' (Coombs, 1970).

To my knowledge, there is no study that corroborates Kearins' work among American Indians showing superior visual spatial skills. However there is one study (Scott, 1983) which shows an interesting difference between Pueblo Indian and Anglo students who were studying to be elementary school teachers. She found that Anglos scored higher on arithmetic and algebra items while Pueblos scored higher on measurement and geometry items. The measurement items appeared to relate more to real world experience while the arithmetic and algebra items were highly symbolic and could be done by rote manipulation. Her advice to teachers was to provide basic mathematics instruction that related computational skill to real word situations.

A number of researchers have tried to determine the causes for the low achievement of some ethnic groups. In a recent book edited by Cocking and Mestre (1988), the authors try to disentangle the various linguistic and cultural influences on learning mathematics. Myers and Milne (1988) concluded that "although the research findings are diverse, in nearly every study one language minority group or another is shown to demonstrate school performance below that of native English speakers" (p259).

Several writers in this same volume (Coking and Chipman, 1988; Leap, 1988; and Myers and Milne, 1988) noted that American Indian and Hispanic children fall consistently behind in mathematics achievement: the other non-English groups such as the Italians, Germans and Chinese often achieve more highly in mathematics than native English speakers (Myers and Milne, 1998). In a large cross-national study, Stigler et al. (1987) reported that "the mean scores of American kindergarten children were below those of Japanese children. By first grade, American children's scores were significantly below those of both Japanese and Chinese children and by fifth grade, the differences were even greater" (p1272). One of their conclusions was that American children spend much less time on mathematics than children in Japan and Taiwan and have less instruction directly from their teachers. In a study with the intention of exposing kindergarteners to more mathematics than is typically the case, the University of Chicago School Mathematics Project (Hedges et al., 1988) found that even though urban children began the school year with lower skills, by the end of the school year they had essentially caught up with their suburban counterparts.

In contrast to the situation with American Indian children for whom the performance "gap" widens as higher grade levels are reached (Leap, 1988), Dawe (1983) reported that Asian children showed consistent and marked improvement in cognitive abilities with years of schooling and exposure to British culture. This may suggest that there is some disadvantage with non-English speaking children when they enter school but as they progress through the schooling system their cognitive skills reach a similar level to English-speaking children. This was confirmed in a study by Butler and Marsh (1986) when testing English-speaking and non-English speaking children in Australia in Year 6. They found that the two groups did not differ in mathematics achievement.

Mayeske et al. (1973 as reported in Myers and Milne, 1988) reanalysed Coleman's Equality of Educational Opportunity data and tested language in the home against a broad cluster of other family background factors (including parental education, occupation, income, family stability and family child-rearing process). The authors concluded that a large relationship between language and achievement "is not present, and that the relationship that does exist can be explained largely by differences among students in socio-economic status" (p80).

This would suggest that the low achievement found among indigenous groups or those that are the most oppressed in society (Blacks and Hispanics) is not necessarily caused by language but by other cultural factors. Nevertheless, the evidence on the linguistic influences remains equivocal because often the more exacting variables (such as proficiency in home language and in English) are not included in these studies. As a result, researchers continue to experiment with bilingual mathematics classes to determine if learning mathematics in one's own language improves achievement. Schindler and Davison (1985) reported that Crow language speaking first grade level children who were taught reading and mathematics in the Crow

language scored higher on a mathematics test than a matching group of Crow language speaking first grade level children who were given initial instruction in English. Cuevas (1984) also reported research which found that when tests were translated, Hispanic students tended to do better on the Spanish version than on the English version.

The issues of language and mathematics are complex. Watson (1987) and Graham (1984) who have done research on the use of language and mathematics with African and Aboriginal children respectively conclude that mathematical meanings are difficult to construct in languages outside the mathematico-technological culture. In addition to language the exposure of children to quantification in many cultures is low (Watson, 1987) and the child-rearing practices (lack of toys such as blocks, jigsaws, mazes) may inhibit spatial and perceptual abilities found in many 'Western' children (Dawe, 1983).

Despite the lack of mathematical concepts occurring in some languages, many researchers (Dawe, 1983 and Graham, 1984) do not suggest that children should be taught only in English or in another European language. Rather they conclude that maintenance of the first language should be taken more seriously as a means of developing the cognitive flexibility of bilingual children. Graham stressed that children need to construct mathematical meanings for themselves and that "learning the language of mathematics" involves learning to make and share mathematical meanings using language appropriate to the context (1988, p125) which for traditional Aboriginal children would most likely be their vernacular language.

In sum, these studies indicate that children from minority groups, especially indigenous ethnic groups, are more likely to fall behind in mathematics performance as they progress through schools. Children from low socioeconomic backgrounds are more vulnerable to failure in a school situation and those whose language is not English and who do not gain proficiency in English at an early age are also more likely to find difficulty in understanding mathematics concepts. However, these studies also stress the importance of maintaining one's own language and relating mathematics activities to real life situations so that mathematical meaning can be gained in one's own living environment. Several of the studies also show that by giving greater attention to teaching mathematics, using more manipulatives and having more time on task, children can improve their performance in mathematics quite significantly.

### The Study

This paper focuses on the mathematical performance of young Aboriginal children not attending 'European' government schools. The particular group studied attend the Strelley Community School, located on pastoral leases in the Pilbara region of Western Australia. Beginning in 1989 an 'enriched' mathematics environment was provided for the Aboriginal children to try to improve their mathematics achievement. Then pre- and post-interviews were given at the beginning and end of the school years in 1989 and 1990. For comparison purposes, children in five other schools were also interviewed about the same time.

#### *Remote Aboriginal School*

Strelley was the first Aboriginal Independent School to be established in Western Australia in 1976. (There are ten independent schools now in existence serving Aboriginal communities in Western Australia as diverse as those living in suburban Perth to the more remote areas near the Great Sandy Desert.) The term "Strelley Community School" is an umbrella term for a number of smaller schools run by Aboriginal groups located approximately 160 kms east of Port Hedland, a small coastal town with a population around 12,000. Port Hedland in turn is approximately 2000 kms from Perth, the capital city of Western Australia.

John and Gwen Bucknall, who have been associated with Strelley for more than twelve years, recently conducted a Review of Aboriginal Independent Schools in Western Australia (1988) and identified the following aims of the Strelley School:

- Teach adults and children basic literacy and numeracy skills in both the vernacular and English.
- Encourage and assist in the future development and enrichment of the vernacular language as an essential component in maintaining feelings of worth and esteem.

- Create a framework within which Aboriginal Teachers will increasingly assume the roles currently filled by White teachers while recognizing the obvious need to allow for the full development of Aboriginal learning styles and contexts.
- Effectively develop skills programs based on the future economic development of the group and in particular pastoral, agricultural and small scale industrial, administrative, managerial and technical skills.

The students in these schools gain initial literacy in Nyangumarta, their first language, and gradually they are introduced to English as a second language. Nyangumarta is taught by Aboriginal teachers who have been trained on site over a number of years. The Aboriginal teachers use Nyangumarta to assist the children in understanding the mathematics concepts which are initially introduced in English.

The Strelley Schools are ideal settings to try to experiment with a new kind of mathematics program. The Aboriginal language takes precedence in the schools and the non-Aboriginal teachers are being encouraged to continually negotiate with the Aboriginal teachers about the nature of the curriculum. To create the foundation for a meaningful mathematics program, Graham (1984) suggests that Aboriginal and non-Aboriginal teachers have to engage in dialogues about mathematical meanings. This should enable teachers to understand how Aboriginal children perceive and talk about their world. From this base, non-Aboriginal teachers can devise experiences from local Aboriginal content before taking the children into western mathematical content which is unknown to them in their environment.

#### *The "Enriched" Program*

It is within this content that Murdoch researchers were invited to extend and enhance the mathematics curriculum. After considerable discussion the Strelley School Committee of Aboriginal elders together with the teachers decided to introduce a new mathematics program that combined Montessori and Mortensen mathematics equipment in one of their schools (see Note 1). Murdoch University researchers felt that this kind of program would create a mathematically rich environment which would minimally conflict with Aboriginal learning styles. It would allow children to move from the concrete to the abstract and from the known to the unknown. Mortensen mathematics was also chosen because it was an extension of Montessori mathematics and it provided a practical, hands-on approach (with material that was considerably less expensive). The materials also incorporated the critical concept of place value that underpins western numeration. It was felt that both of these programs might offer an effective bridge between Aboriginal learning styles and the more formal western learning approach. Both the Montessori and Mortensen mathematical approaches rely very heavily on didactic materials with the Montessori materials more useful for the very young children and the Mortensen materials more useful for children from about 7 years of age. All the Strelley schools now use the Mortensen materials but only one of the schools has acquired the Montessori materials.

In addition to these two programs, the researchers gave workshops for teachers on aspects of teaching space, number measurement and on the use of calculators. An emphasis of all the workshops was the use of a 'do, talk and record' model of teaching and learning mathematics.

#### *Sample Schools*

Based on the evidence of previous research which found that the degree of contact children have with the mathematico-technological world will affect their level of mathematical performance, schools were selected to represent different geographical locations and different socioeconomic areas. The schools were not chosen at random; rather, they were conveniently located. In each school twelve 5 and 6 year old children, both boys and girls was selected for interviewing in 1989 and a slightly larger number of 6 and 7 year olds were interviewed in 1990 (see Table 1).

The two convenient locations for choosing schools were Port Hedland and Perth. In addition to location, the Aboriginal students in two Port Hedland schools were interviewed because there was a high probability that the children in these schools would be of the same language and family groupings as those in the Strelley communities. However, their life in a rural town would be more conducive to introducing them to 'western' concepts in mathematics. Three schools in Perth were chosen to represent a working class school, a

middle class school and a middle class school with a Montessori program. Principals of the three schools were approached: a private Montessori school, located in a middle class neighbourhood, a state school located in a middle class suburb, and another state school located in a working class area. A selection of 'typical' children, who were neither recognised as especially bright nor as especially slow in terms of their development was made by the teachers concerned, rather than by a random procedure; nonetheless, in each case it was felt that the children were reasonably representative of their respective groups. Table 1 summarises the sampling of children. School 6 (a school in Perth which had Aboriginal children) was dropped because of the small number who were interviewed twice. By coincidence all the older children (6 year olds) were absent the second interviewing time, leaving only the pre-primary children, thus biasing the school sample considerably. The figures in bold text indicate the number of children interviewed on all four occasions. The figures in brackets indicate the extra children interviewed for the first and second times on the third and fourth occasions in 1990. In later parts of this paper, comparisons are made between groups of schools.

|                | Sch<br>1 | Sch<br>2 | Sch<br>3 | Sch<br>4 | Sch<br>5 | Sch<br>6 | Sch<br>7 | Sch<br>8 | M       | F       |
|----------------|----------|----------|----------|----------|----------|----------|----------|----------|---------|---------|
| Time 1<br>(89) | 9        | 5        | 13       | 8        | 12       | 5        | 10       | 9        | 38      | 33      |
| Time 2<br>(89) | 9        | 5        | 13       | 7        | 11       | 5        | 9        | 9        | 36      | 32      |
| Time 3<br>(90) | 9 (20)   | 2 (2)    | 7 (6)    | 3 (5)    | 9 (23)   | -        | 9 (21)   | 5 (12)   | 22 (48) | 22 (41) |
| Time 4<br>(90) | 9 (18)   | 2 (2)    | 6 (4)    | 2 (3)    | 9 (22)   | -        | 8 (15)   | 4 (10)   | 21 (36) | 19 (38) |

Table 1: Sample sizes for the eight schools on the four interview occasions.

The Strelley schools (School 2 includes the outposts at Mijiji Maya and Lalla Rook and School 3, Warralong) are grouped together even though slightly different programs operated at each of the schools. They represent children in a remote desert community with little contact with mathematics outside of school. The two middle class schools (1 & 5) are similar in terms of their clientele. The children's parents are mainly in administrative and professional occupations. They live in comfortable suburbs in metropolitan Perth. One of the schools was a private Montessori school and the other a government school which was well resourced. The Other working class category looks like an odd mixture at first since we combined rural Aboriginal children with White children living in a working class suburb of metropolitan Perth. The Aboriginal children were attending a government school in a coastal town and were mainly from working class backgrounds. The White children were in a government school that was categorised as a 'priority' school because the children came from 'disadvantaged' backgrounds. A substantial percentage of the children are on welfare, their parents unemployed. Some might describe this group as part of the 'underclass' of Perth and similar to the backgrounds of many of the Aboriginal children interviewed.

Besides the 'cultural' reasons for categorising the children into these three groups, there were also statistical reasons. When we analysed the scores after the first interviewing time, we discovered that the three groups were placed on a continuum such that the middle class schools grouped together, the Other working class schools came next and the Strelley schools followed in three clusters. Therefore, we decided on the following three broad designations:

|                             |                     |
|-----------------------------|---------------------|
| Strelley schools            | Schools 2 & 3       |
| White middle class schools  | Schools 1 & 5       |
| Other working class schools | Schools 4, 6, 7 & 8 |

Table 2 shows the actual numbers used in the data analysis by school groups. The figures in bold text indicate sequential interviewing on four occasions and the figures in brackets indicate the children interviewed for the first and second times on the third and fourth occasions.

| Time | White Middle Class | Other Work Class | Strelley schools |
|------|--------------------|------------------|------------------|
| 1    | <b>21</b>          | <b>32</b>        | <b>18</b>        |
| 2    | <b>20</b>          | <b>30</b>        | <b>18</b>        |
| 3    | <b>18</b> (43)     | <b>17</b> (38)   | <b>9</b> (8)     |
| 4    | <b>18</b> (40)     | <b>14</b> (28)   | <b>8</b> (6)     |

Table 2: Sample sizes for the three school groups on four occasions.

#### *Interview Schedule*

To assess the levels of performance of the Aboriginal and comparison children, an interview schedule was constructed. The schedule was initially based on work conducted by The University of Chicago School Mathematics Project in their evaluation of Kindergarten Everyday Mathematics (Hedges *et al.*, 1987). It was originally hoped that some comparisons could be made between the performance of young Western Australian students and students of similar ages in the Chicago study, especially since the latter had involved a number of groups of students from minority cultures.

A major feature of the Chicago work was that it involved face to face interviews with each student, rather than a more formal written process. This seemed to be more likely than a written test to lead to valid information from young students, especially those who could not yet read with confidence. However, on closer inspection, the Chicago interview was inappropriate for the present purposes in some important respects. In the first place, it did not involve the use of physical materials, and it was felt that this would be inconsistent with classroom practices in Western Australia, especially those to be developed at the Strelley School. Secondly, the interview was rather short, and did not encompass a sufficiently wide range of tasks to adequately reflect the Western Australian curricula. Thirdly, it did not pay sufficient attention to how students arrived at their answers, and it was hoped that some diagnostic information might be obtained through that means. Consequently, a new interview schedule was developed for the present study.

To get a comprehensive picture of mathematical performance of the children, clusters of interview questions were devised in the following areas:

#### *Quantification*

These questions assessed whether students could count small sets of objects, how they went about doing so, and examined how far they could count. Attention was paid to how children counted (e.g. whether or not they touched each object when counting) as well as how accurately they did so.

#### *Operations*

These questions were concerned with whether children realised that addition and subtraction were involved in practical situations. The subtraction questions dealt with each of the three ways of thinking about subtraction: taking away, comparison and complementary addition.

#### *Reading*

Questions determined whether or not children could recognize and read numbers of 1, 2 and 3 digits, and with whether they understood place value with two-digit numbers.

#### *Patterns*

Both number and spatial patterns were used to see whether children could detect, describe and use sequential patterns.

#### *Shapes*

These questions determined whether students knew the conventional names for the two-dimensional shapes that were used to make the spatial patterns.

### *Measurement*

Each of length, mass and money were dealt with in questions concerned with the basic concepts.

To accompany the interview schedule, a kit of materials was developed, consisting mainly of materials commonly found in schools (e.g. blocks) or the natural environment (e.g. stones), and a coding sheet was devised. The interview was untimed, in the sense that it was intended that children could take as long as they felt necessary to answer the questions. In fact, early administrations suggested that most children completed the interview as well as they could within 20 minutes, and no children required more than 30 minutes (see Note 1).

### *Interview Schedule Translation and Administration*

Early administrations of the interviews were videotaped so that the interview situation could be adequately described to the Strelley community and especially to those teachers who would be involved in the interviewing. This also assisted in developing a good translation of the interview schedule into Nyangumarta. The children videotaped did not seem to be unduly concerned by this procedure, and the interviews that were taped were not substantially different from those that were not taped.

Translation of the interview schedule to Nyangumarta took place at the Warralong school. The translation process was supported by videotapes and an extensive discussion of the purpose of each question. A group consisting of two senior school members (both native speakers of Nyangumarta), the school principal (a teacher-linguist who has worked several years in Nyangumarta) and some of the Murdoch research team spent a full day discussing the difficulties that emerged in the translation. It was clear that several of the terms used in the interview, and common English speech patterns, did not have ready equivalents in Nyangumarta, thus complicating the translation process. The exercise was regarded as a valuable one for the community leaders and the school principal to become more aware of the different language demands of mathematics in the two languages. There was considerable discussion about particular words, and some concern even after completing the interviewing that the appropriate words had not been found to convey accurately at least one of the questions.

For example, one question involved placing two boxes in front of the children and then asking them, "Which box is heavier?" In colloquial speech on the videotape, this became "Tell me which box is heavier". The question does not ask children to lift the boxes to discover which is heavier. (In fact, the main point of the question is to see whether children know that you cannot tell which is heavier *unless* you lift them; in this case, the smaller of the two boxes is actually heavier.) This question was translated to read "Look! Which box is heavier?". It is conceivable that the Aboriginal children at Strelley schools may have felt that they were being asked to tell which is heavier by looking rather than by whatever means they wanted, a subtle, but potentially important difference from the original question.

In addition to considering the actual questions asked, the translation process also dealt with the materials used in the interviews. It was decided to use some local equivalents of some of the natural materials used in the English language schedule (notably in Question 8, where *jima*, small local berries, were substituted for gumnuts, which were not locally available). Although some other materials might be regarded as foreign to Aboriginal culture (e.g. coloured blocks), these were retained in the interview, since children were commonly using such materials already in the Strelley schools, rendering them more familiar than might be otherwise expected. In sum, a number of factors were considered to try to allow the Aboriginal children to perform to the best of their abilities, even though the interview situation would have been foreign to them. It is important to note that since the interview was given verbally to all children we were not investigating their ability to read either English or Nyangumarta. Nevertheless, we were testing their listening skills either in their own language or in a second language (and sometimes with interviewers who had different accents to their own).

The interview was designed to be administered by a single person, who would both ask all the questions, present students with the appropriate materials and complete the coding in relation to their responses. Although extensive coder reliability studies were not conducted, checks were made with early administrations of the test in which a second person simultaneously coded children's responses. These checks did not reveal any difficulties in this respect, and did not suggest that more detailed studies of this kind would be necessary to guarantee reliability. In the Strelley community schools, the teacher-linguist coded the children's responses as the questions were asked by Aboriginal teachers.

## Results

To understand the relationships among the interview questions, and to see whether it was necessary to consider clusters of items rather than all the items as a whole, a Rasch analysis of the responses of 97 children to these items was conducted. This analysis was used for two purposes: to see the extent to which the interview items fitted together and thus rendered data interpretable, and to locate the items along a continuum of difficulty (Wright & Stone, 1980). Inspection of the resulting item fit statistics suggested that there was reasonable conformity of the data to the Rasch model, with the exception of three questions. Closer inspection of these items revealed that there was clear evidence of guessing in one question and that one was excluded. In addition to these exclusions, two more items were eliminated due to the differences in the interview schedules given over the two years. As a results, we added 26 items to get a single total score, rather than confine the analysis to each of the separate sub-scales.

Table 3 below indicates the means and standard deviations of the entire group of students on total scores on the four and two interviewing occasions. The figures in bold text indicate the sequential interviewing on four occasions. Those who were first interviewed in March 1989 are seen as a distinct group from those who were first interviewed in April 1990 even though they were actually scored on the same interview schedule. The first group is a younger group including five and six year olds in 1989 and the second group is an older group including six and seven year olds in 1990. The means indicate that the older children started out scoring 4.6 points higher than the younger children. Both groups gained approximately the same number of points in the course of the year, 3.6 (older) and 3.4 (younger).

| Time | March 89          | Nov 89            | April 90          | Dec 90            |
|------|-------------------|-------------------|-------------------|-------------------|
| 1    | <b>14.1 (7.2)</b> | -                 | 18.7 (6.4)        | -                 |
| 2    | -                 | <b>17.5 (6.4)</b> | -                 | 22.3 (4.4)        |
| 3    | -                 | -                 | <b>20.1 (4.2)</b> | -                 |
| 4    | -                 | -                 | -                 | <b>22.0 (3.5)</b> |

Table 3: Total mean scores and standard deviations on four interviewing occasions.

The group mean change from Time 1 to Time 2 and from Time 3 to Time 4 was statistically significant, representing an improvement of several standard errors of the mean. Its educational significance is less clear-cut. Roughly speaking, the groups' mathematical performance has increased a little more than half a standard deviation over a school year. The small size of this increase might be accounted for in several ways. In the first place, several of the questions asked are not dealt with directly in the usual mathematics curriculum of children of these ages, and so might not be expected to change much over the course of the year. Later in this paper, a detailed examination of the changes for individual items will elaborate this idea. Secondly, the change is artificially depressed by the fact that there is a slight 'ceiling effect', since some children correctly answered most of the questions at the beginning of the year, and thus the interview was not able to detect any substantial improvements in their performance by the end of the year. Of most significance, however, is the interpretation that growth of mathematical performance in these early years of schooling is a naturally slow process, so that many children by the end of the year will not have reached the levels attained by other children at the beginning of the year.

### *Schools and school groups*

To further study and understand the growth of mathematical performance in young Aboriginal children, it is helpful to divide the data in two different ways. The first of these involves looking at subsamples of the children, and, in particular, the broad groupings of schools into those at Strelley, the White middle class schools and the other schools (rural Aboriginal and White working class schools). There is a rather consistent gain in mean score for most schools of between three and four points over the course of the first year and two points over the second year. Again children interviewed in 1989 (younger group) began with lower scores in two of the groups (White middle class and Other working class) than those interviewed in 1990 (older children). It is important to note that there was no variation for the Strelley group because in each year we interviewed as many children as we could and the numbers are small (9 in 1989 and 8 in 1990). The children would have differed in age but only slightly. It appears that all of the children at Strelley whether 5 or 6 year olds are starting out with a low level of mathematics performance on the questions we asked. Nevertheless, they did show the same level of improvement over the two years as the other groups.

Over the three groups, gains in mean scores over the course of the two years are rather similar, so that existing differences between schools at the beginning of the year are still evident at the end of the year. In broad terms, the White middle class schools have the highest performance, followed by the Other working class schools and the Strelley Group respectively. Again the figures in bold indicate the sequential interviewing on four different occasions.

| Group            | Time            | Total Scores |
|------------------|-----------------|--------------|
| White Middle     | 1 (March 89)    | 19.7 (4.8)   |
|                  | 2 (November 89) | 22.8 (4.2)   |
|                  | 3 (April 90)    | 22.7 (2.5)   |
|                  | 4 (December 90) | 24.1(1.4)    |
|                  | 1 (April 90)    | 22.2 (3.3)   |
|                  | 2 (December 90) | 24.7 (1.5)   |
| Other Work Class | 1 (March 89)    | 13.5 (6.4)   |
|                  | 2 (November 89) | 16.6 (5.7)   |
|                  | 3 (April 90)    | 20.4 (2.8)   |
|                  | 4 (December 90) | 22.9 (1.4)   |
|                  | 1 (April 90)    | 16.8 (6.3)   |
|                  | 2 (December 90) | 21.1 (4.1)   |
| Strelley         | 1 (March 89)    | 8.7 (6.6)    |
|                  | 2 (November 89) | 13.0 (5.6)   |
|                  | 3 (April 90)    | 14.7 (4.4)   |
|                  | 4 (December 90) | 16.1 (2.7)   |
|                  | 1 (April 90)    | 8.2 (4.9)    |
|                  | 2 (December 90) | 12.3 (2.1)   |

Table 4: Mean and standard deviations of total scores for the three school groups on four interviewing occasions.

The line graphs in Figure 1 and Figure 1a illustrate the differences between the three school groups over the four interviewing occasions and two interviewing occasions respectively in a more pictorial way. They show how the differences between the three groups of schools were very similar on times 1 and 2 but not as similar on times 3 and 4. The dip in the middle class group brought their mean closer to the other group and the increases in the other group on time 4 brought their mean closer to the middle class group.

An analysis of variance was carried out using the difference scores (over the first two interviewing occasions) as the independent variable, and with the school groups as the factor, to determine whether there were significant differences in the changes observed in the school groups over the course of the year. The results indicated that there were no significant differences between the groups. This result is consistent with the informal observations above that there is a considerable consistency in the patterns of change in total scores over the two years, although there are substantial differences between schools in terms of the overall levels of mathematical performance of their children.

Since there was some variability of ages within the three school groups, it was thought prudent to investigate whether there were significant differences in terms of the changes observed over a school year, after the effects of age were taken into account. Accordingly, an analysis of covariance of these data was also conducted, with age in years and months as the covariate. The results showed that the lack of difference between school groups persisted, even after the effects of age are taken into account.

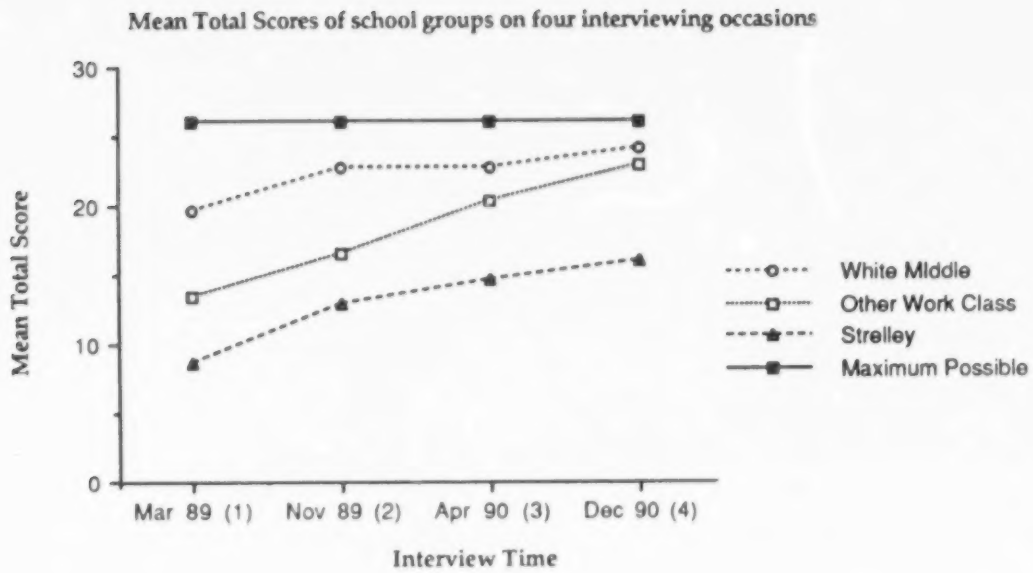


Figure 1: Mean Total Scores on four interviewing occasions.

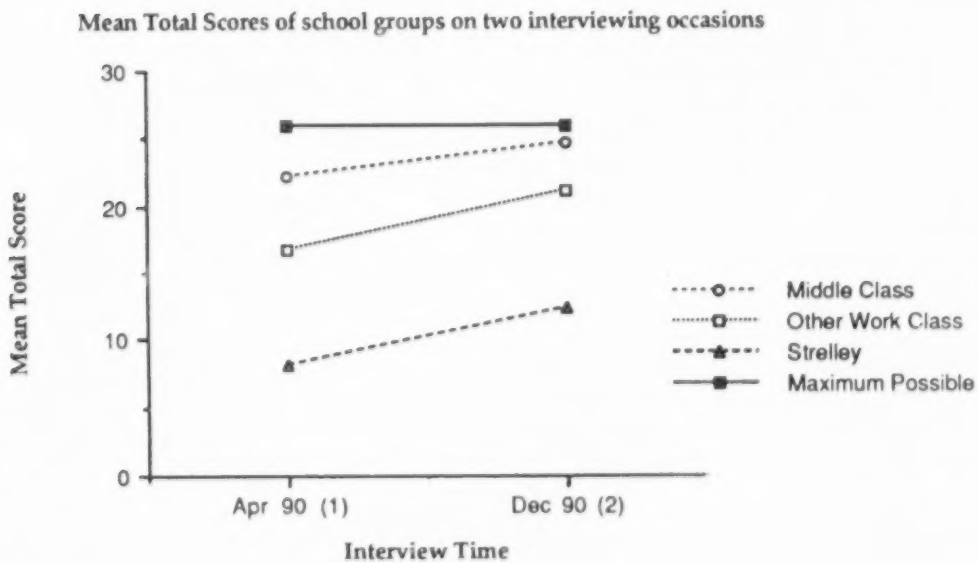


Figure 1a: Mean Total Scores on two interviewing occasions

### Subscale scores

Another way of looking at the data concerns subsamples of the interview questions themselves into subscales of several related items. This kind of analysis allows for growth in different aspects of mathematical performance to be compared. It needs to be noted at the outset that these various examinations of the data are not independent of each other, since they use subsets of the same data. In addition, since the children and their schools were not selected at random, it is not intended to make strong inferences to larger populations here. Rather, it is hoped that trends of interest might be noted and informal conclusions about some of these reached. Six subscales were defined, based on the original structure of the interview schedule.

Table 5 below summarises the subscales on the four interviewing occasions. This table indicates that the areas of operations, reading and patterns are more difficult for the children and there is greater variation among the children's responses. However, the overall results show a ceiling effect on all the questions but particularly on the quantitative and shapes questions. The ceiling effect is much more of a problem with the middle class and other working class schools than with the Strelley schools. This has made it difficult to alter the interview schedule for all children. (Nevertheless, the researchers have decided that it will be necessary to alter the difficulty level of the schedule for the interviewing session at the end of 1991.)

| VARIABLE   |           |           |           |           |           |           |
|------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Time       | Quant-*4  | Oper-4    | Read-5    | Pattn-6   | Shape-4   | Meas-3    |
| 1 (Mar 89) | 2.7 (1.5) | 1.8 (1.3) | 1.8 (1.4) | 3.3 (2.2) | 2.6 (1.4) | 2.0 (0.9) |
| 2 (Nov 89) | 3.2 (1.2) | 2.0 (1.3) | 2.8 (1.7) | 4.1 (1.8) | 3.1 (1.1) | 2.1 (0.9) |
| 3 (Apr 90) | 3.5 (0.9) | 2.4 (1.1) | 3.1 (1.5) | 5.3 (1.1) | 3.5 (0.7) | 2.3 (0.8) |
| 4 (Dec 90) | 3.5 (0.8) | 3.1 (1.2) | 3.9 (1.1) | 5.3 (1.2) | 3.7 (0.6) | 2.5 (0.7) |
| 1 (Apr 90) | 3.2 (1.3) | 2.2 (1.3) | 3.0 (1.7) | 4.6 (1.7) | 3.4 (1.0) | 2.2 (0.9) |
| 2 (Dec 90) | 3.6 (0.8) | 3.1 (1.2) | 3.9 (1.3) | 5.5 (1.2) | 3.7 (0.6) | 2.5 (0.7) |

\*Maximum score for each group of items.

Table 5: Means and standard deviations of subscale scores on four and two interviewing occasions.

### School Groups

The following Tables 6a-6f summarise the subscale scores for the three school groups on four interviewing occasions. Changes of scores on groups of items are of interest to see whether growth over the course of the interviewing times occurred uniformly in the various areas examined.

### Quantification

There were very little differences between the school groups on the quantitative questions which involved counting between 6 and 15 blocks. By Time 4 most of the children had the maximum score on this section in all schools although it is still noticeable that the Strelley group had lower mean scores, especially when comparing the 1990 groups. Those children who were interviewed on four occasions were able to improve in this area to match the other groups by the end of two years. The greatest improvement was shown by the Other working class children. It was obvious that for the Middle class children, a ceiling effect was operating from the first time of interviewing in both 1989 and 1990.

|                 | White Middle Class | Other Working Class | Strelley  |
|-----------------|--------------------|---------------------|-----------|
| Time 1 (Mar 89) | 3.5 (0.7)          | 2.3 (1.4)           | 2.3 (1.7) |
| Time 2 (Nov 89) | 3.8 (0.5)          | 3.0 (1.2)           | 2.9 (1.4) |
| Time 3 (Apr 90) | 3.8 (0.5)          | 3.7 (0.7)           | 2.5 (1.1) |
| Time 4 (Dec 90) | 3.5 (0.7)          | 3.6 (0.6)           | 3.4 (1.2) |
| Time 1 (Apr 90) | 3.5 (0.9)          | 3.1 (1.3)           | 1.6 (1.7) |
| Time 2 (Dec 90) | 3.7 (0.5)          | 3.6 (0.9)           | 2.8 (1.5) |

Table 6a: Means and standard deviations on four quantification items.

### Operations

The operations area showed the greatest differences between the groups with the Strelley schools considerably lower in this area than the other two groups. There were two addition items and two subtraction items. The subtraction items proved to be very difficult, especially for the Strelley children, possibly for linguistic as well as mathematical reasons. Since the related subtraction concepts were not taught formally at the Strelley schools, it seems that little growth occurs in this area outside formal schooling.

|                 | White Middle Class | Other Working Class | Strelley  |
|-----------------|--------------------|---------------------|-----------|
| Time 1 (Mar 89) | 2.7 (1.0)          | 1.6 (1.2)           | 0.8 (1.0) |
| Time 2 (Nov 89) | 3.4 (0.6)          | 1.9 (1.2)           | 0.8 (0.7) |
| Time 3 (Apr 90) | 3.1 (0.7)          | 2.3 (0.7)           | 1.2 (1.1) |
| Time 4 (Dec 90) | 3.8 (0.7)          | 3.1 (0.6)           | 1.4 (1.1) |
| Time 1 (Apr 90) | 3.0 (0.9)          | 1.7 (1.3)           | 0.5 (0.5) |
| Time 2 (Dec 90) | 3.7 (0.5)          | 2.7 (1.0)           | 0.5 (0.5) |

Table 6b: Means and standard deviations on four operations items.

### Reading Numerals

The reading questions asked children to read the numbers: 3, 17, 58, 100 and 106. Generally, larger numbers were more difficult to read, the exception being 100, which is clearly a special case. By the end of the two years, growth was observed for each group, although some students clearly had not mastered recognition of large numbers. Again the Strelley group started out considerably behind in both 1989 and 1990 and remained that way in both years. At the end of 1990 (4 occasions) there was about a one point difference between each of the groups.

|                 | White Middle Class | Other Working Class | Strelley  |
|-----------------|--------------------|---------------------|-----------|
| Time 1 (Mar 89) | 2.5 (1.5)          | 1.6 (1.3)           | 1.4 (1.3) |
| Time 2 (Nov 89) | 4.0 (1.4)          | 2.2 (1.6)           | 2.4 (1.5) |
| Time 3 (Apr 90) | 3.8 (1.1)          | 2.7 (1.5)           | 2.4 (1.5) |
| Time 4 (Dec 90) | 4.4 (0.7)          | 3.9 (1.1)           | 2.9 (1.4) |
| Time 1 (Apr 90) | 4.1 (1.1)          | 2.3 (1.5)           | 0.9 (1.4) |
| Time 2 (Dec 90) | 4.6 (0.7)          | 3.5 (1.0)           | 1.3 (0.5) |

Table 6c: Means and standard deviations on five reading items.

### Pattern

The pattern items (putting correct shapes in a pattern) showed less uniform growth than those of the other areas. There seemed to be linguistic and cultural explanations for this since many children clearly found it difficult to describe a pattern whereas others found it much easier. The differences between the groups were quite substantial with the White middle class group achieving scores close to the maximum from Time 1 and the other group achieving closer to the maximum by Time 4. The Strelley group was four points below the maximum at the start of interviewing and had improved by a little over one point but were considerably below the other two groups by the end of the two years. There is little work with patterns in a sequence in either the Montessori or Mortensen programs and it is unlikely that these children would have been introduced to this type of exercise in their out of school environments.

|                 | White Middle Class | Other Working Class | Strelley  |
|-----------------|--------------------|---------------------|-----------|
| Time 1 (Mar 89) | 4.8 (1.7)          | 3.2 (1.9)           | 1.7 (1.9) |
| Time 2 (Nov 89) | 5.3 (1.3)          | 4.0 (1.6)           | 3.0 (1.9) |
| Time 3 (Apr 90) | 5.6 (0.8)          | 5.5 (0.8)           | 4.3 (1.8) |
| Time 4 (Dec 90) | 5.8 (0.5)          | 5.9 (0.3)           | 3.4 (1.3) |
| Time 1 (Apr 90) | 5.3 (0.9)          | 4.1 (2.0)           | 3.0 (1.5) |
| Time 2 (Dec 90) | 5.9 (0.4)          | 5.2 (1.4)           | 3.7 (1.7) |

Table 6d: Means and standard deviations on six pattern items.

### Shape

The items on identifying the four shapes (circle, triangle, square and rectangle) indicated whether children had access to the conventional names for geometric shapes. Each of these showed uniform growth, with the word 'rectangle' much more difficult than the other three. It is also significant that the Strelley children did not know these words when interviewed at Time 1 but did at Time 4 because they are included in the Montessori program. The White middle class and Other working class children were more likely to know the words at the first interview and hence were only able to improve slightly over the period of two years.

|                 | White Middle Class | Other Working Class | Strelley  |
|-----------------|--------------------|---------------------|-----------|
| Time 1 (Mar 89) | 3.4 (1.1)          | 2.8 (1.2)           | 1.2 (1.0) |
| Time 2 (Nov 89) | 3.6 (0.9)          | 3.2 (1.0)           | 2.4 (1.1) |
| Time 3 (Apr 90) | 3.7 (0.6)          | 3.8 (0.4)           | 2.7 (0.7) |
| Time 4 (Dec 90) | 3.8 (0.5)          | 3.8 (0.4)           | 3.2 (0.7) |
| Time 1 (Apr 90) | 3.7 (0.6)          | 3.4 (1.0)           | 1.6 (1.4) |
| Time 2 (Dec 90) | 3.9 (0.3)          | 3.7 (0.6)           | 2.7 (0.8) |

Table 6e: Means and standard deviations on four shape items.

### Measurement

Children were very successful at identifying which of two pencils was longer, but many did not realize that weight can only be determined by lifting, rather than by looking. When asked which of two boxes is heavier, the Strelley children were more likely to guess rather than to lift the boxes to find the correct answer. The last question asked children to find a five cent coin among a set of coins and almost all children were able to do that, although there were still a few of the Strelley children who were uncertain about which was the five cent coin indicating less familiarity with coins in their environment.

|                 | White Middle Class | Other Working Class | Strelley  |
|-----------------|--------------------|---------------------|-----------|
| Time 1 (Mar 89) | 2.8 (0.4)          | 1.9 (1.0)           | 1.3 (0.8) |
| Time 2 (Nov 89) | 2.7 (0.6)          | 2.2 (0.8)           | 1.4 (0.9) |
| Time 3 (Apr 90) | 2.6 (0.7)          | 2.4 (0.7)           | 1.4 (1.0) |
| Time 4 (Dec 90) | 2.7 (0.5)          | 2.5 (0.6)           | 1.9 (0.8) |
| Time 1 (Apr 90) | 2.5 (0.6)          | 2.1 (0.9)           | 0.6 (0.7) |
| Time 2 (Dec 90) | 2.8 (0.5)          | 2.3 (0.7)           | 1.3 (0.8) |

Table 6f: Means and standard deviations on three measurement items.

Children were asked to count as high as they could and many children required careful prompting and encouragement to do so. Not all numbers were counted; children were asked to stop at 41 and skip to 68, then stop at 73 and skip to 98, stop at 101 and skip to 197-203 and then finally skip to 997 and count to 1003. Data were collapsed to form categories and the numbers that children were stopped at, as shown in Table 7. These data show a clear shift over the course of the interviewing times from the lower to the higher categories. Thus, while 24% of the children could not count past ten at the beginning of the year, there were only 6% in this position at the end of the first year and none at the end of the second year. At the higher end, only 8% could count to 101 initially, this group had swollen to 50% by the end of the interviewing. These observations are consistent with the observation that children's performance on the quantification items also increased substantially over the year.

| Highest Number Reached |      |       |      |      |      |      |      |    |        |
|------------------------|------|-------|------|------|------|------|------|----|--------|
| Time                   | 0-10 | 11-40 | 41   | 73   | 101  | 203  | 1003 | N  | Median |
| 1 Mar 89               | 23.9 | 49.3  | 11.3 | 4.2  | 8.5  | 0.0  | 2.8  | 71 | 24     |
| 2 Nov 89               | 5.9  | 42.6  | 17.6 | 11.8 | 14.7 | 5.9  | 1.5  | 68 | 41     |
| 3 Apr 90               | 6.8  | 38.7  | 18.2 | 11.4 | 18.2 | 4.5  | 2.3  | 44 | 41     |
| 4 Dec 90               | 0.0  | 7.5   | 20.0 | 7.5  | 50.0 | 5.0  | 10.0 | 40 | 101    |
| 1 Apr 90               | 12.4 | 30.3  | 3.4  | 13.5 | 24.7 | 9.0  | 6.7  | 89 | 69     |
| 2 Dec 90               | 2.7  | 17.6  | 6.8  | 5.4  | 31.1 | 17.6 | 18.9 | 74 | 101    |

Table 7: Percentages of children counting over the four occasions.

| Highest Number Reached |      |      |       |      |      |      |      |      |    |        |
|------------------------|------|------|-------|------|------|------|------|------|----|--------|
| Group                  | Time | 0-10 | 11-40 | 41   | 73   | 101  | 203  | 1003 | N  | Median |
| Middle                 | 1    | 4.8  | 47.6  | 19.0 | 0.0  | 19.0 | 0.0  | 9.5  | 21 | 39     |
| Class                  | 2    | 0.0  | 20.0  | 15.0 | 10.0 | 40.0 | 10.0 | 5.0  | 20 | 101    |
|                        | 3    | 0.0  | 27.8  | 5.6  | 0.0  | 27.8 | 0.0  | 5.6  | 18 | 101    |
|                        | 4    | 0.0  | 0.0   | 5.6  | 5.6  | 55.6 | 11.1 | 22.2 | 18 | 101    |
|                        | 1    | 0.0  | 14.0  | 7.0  | 11.7 | 44.1 | 9.4  | 14.0 | 43 | 101    |
|                        | 2    | 0.0  | 2.5   | 2.5  | 0.0  | 37.5 | 25.0 | 32.5 | 40 | 203    |
| Other                  | 1    | 28.1 | 56.3  | 6.3  | 9.4  | 0.0  | 0.0  | 0.0  | 32 | 18     |
| Work                   | 2    | 6.7  | 53.3  | 13.3 | 20.0 | 3.3  | 3.3  | 0.0  | 30 | 38     |
| Class                  | 3    | 5.9  | 41.2  | 23.5 | 29.4 | 0.0  | 0.0  | 0.0  | 17 | 41     |
|                        | 4    | 0.0  | 0.0   | 21.4 | 14.3 | 64.3 | 0.0  | 0.0  | 14 | 101    |
|                        | 1    | 15.8 | 50.0  | 10.5 | 5.3  | 7.9  | 10.5 | 0.0  | 38 | 29     |
|                        | 2    | 3.6  | 32.1  | 10.7 | 10.7 | 28.6 | 10.7 | 3.6  | 28 | 73     |
| Strelley               | 1    | 38.9 | 38.9  | 11.1 | 0.0  | 11.1 | 0.0  | 0.0  | 18 | 20     |
|                        | 2    | 11.1 | 50.0  | 27.8 | 0.0  | 5.6  | 5.6  | 0.0  | 18 | 30     |
|                        | 3    | 22.2 | 44.5  | 33.3 | 0.0  | 0.0  | 0.0  | 0.0  | 9  | 22     |
|                        | 4    | 0.0  | 37.5  | 50.0 | 0.0  | 12.5 | 0.0  | 0.0  | 8  | 41     |
|                        | 1    | 62.5 | 25.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 8  | 10     |
|                        | 2    | 16.7 | 50.0  | 16.7 | 16.7 | 0.0  | 0.0  | 0.0  | 6  | 34     |

Table 8: Percentage of children counting over four occasions.

There was clear improvement at each school over the year as far as counting was concerned, reflecting the attention paid to this aspect in the early stages of schooling. Table 8 shows the growth in the median of the highest number counted by each school group. The differences between the groups were still noticeable with the Middle class schools consistently being able to obtain a median of 101 the second interviewing time with some children reaching 1003, the other schools only reaching a median of 101 by the fourth interviewing time and the Strelley school progressing up to the median of 41 which was two levels before reaching 101.

*Counting by tens*

Children were asked to count by tens out loud, having been given the first two terms, "10, 20....". Table 9 indicates the percentages of children who could count by tens past 20 and past 100 over the four interviewing occasions. These tasks were very difficult for most children at the beginning of the year. By the end of the two years, about one third of the children could count by tens past 100. This is quite a change considering that almost two thirds of the children could not count by tens past 20 at the beginning of 1989. Although the figures are not broken down here, it is interesting that students tend to fall into two camps: those who can count by tens and those who cannot. That is, few students reached middle numbers; rather they could reach high numbers, like 100, or could not tackle the task at all.

| Time         | % past 20 | % past 100 |
|--------------|-----------|------------|
| 1 (March 89) | 33.3      | 2.9        |
| 2 (Nov 89)   | 48.5      | 7.4        |
| 3 (April 90) | 52.2      | 11.4       |
| 4 (Dec 90)   | 52.5      | 30.0       |
| 1 (April 90) | 30.3      | 19.1       |
| 2 (Dec 90)   | 41.9      | 37.0       |

**Table 9:** Percentage of children who could count by tens past 20 and past 100 on four interviewing occasions.

Although comparisons by school groups here are rather fragile, because of both the numbers of students involved and the differences between school curricula, the substantial changes in the Strelley schools are perhaps noteworthy. They suggest that, unlike many other areas, the children's performance is substantially above that of the Other working class schools and more like that of the White middle class schools for counting past 20. However, there appears to be a barrier in both the Other schools and the Strelley schools when reaching the number 100 (few could pass 100 either at Time 1 or Time 4 in the 1989 groups or at Time 1 or Time 2 in the 1990 groups. It is likely that more attention was paid to counting by ten in the Strelley and White middle class schools than in the Other working class schools, because the materials used, both Mortensen and Montessori, emphasized this aspect, at least in the Strelley schools and in one of the middle class schools with the Montessori program.

| Time         | Middle Class |         | Other Work.Class |         | Strelley |         |
|--------------|--------------|---------|------------------|---------|----------|---------|
|              | % > 20       | % > 100 | % > 20           | % > 100 | % > 20   | % > 100 |
| 1 (March 89) | 38.1         | 9.5     | 23.3             | 0.0     | 44.4     | 0.0     |
| 2 (Nov 89)   | 45.0         | 20.0    | 30.0             | 0.0     | 83.3     | 5.6     |
| 3 (April 90) | 55.5         | 27.8    | 35.3             | 0.0     | 77.8     | 0.0     |
| 4 (Dec 90)   | 33.3         | 66.7    | 50.0             | 0.0     | 100.0    | 0.0     |
| 1 (April 90) | 41.9         | 37.2    | 18.5             | 2.6     | 25.0     | 0.0     |
| 2 (Dec 90)   | 27.5         | 92.5    | 53.5             | 3.6     | 83.3     | 0.0     |

**Table 10:** Percentage of children who could count by tens past 20 and past 100 on four interviewing occasions.

### Counting by fives

Children were also asked to count by fives out loud, having been given the first two terms, "5, 10....". Table 11 below indicates the percentages of children who could count by fives past 10 and past 100 over the four interviewing occasions. There was improvement over the course of the two years; however, again there appears to be a barrier at 100 where less than a third of the children can count by fives past 100. An even larger percentage (about 77%) than for those counting by tens could not count by fives when the interviewing began in 1989.

| Time            | % past 10 | % past 100 |
|-----------------|-----------|------------|
| 1 (March 89)    | 18.6      | 4.3        |
| 2 (November 89) | 28.0      | 8.8        |
| 3 (April 90)    | 36.4      | 6.8        |
| 4 (December 90) | 40.0      | 32.5       |
| 1 (April 90)    | 20.2      | 16.9       |
| 2 (December 90) | 31.1      | 37.8       |

Table 11: Percentage of children who could count by fives past 10 and past 100 on four interviewing occasions.

Table 12 below summarises the counting by fives on four occasions for the three school groups. The differences between the groups that were noticeable in counting by tens were repeated in counting by fives. The Strelley group was more like the middle class group in counting past 10; whereas very few of the Other working class and the Strelley groups could count past 100 when counting by fives.

| Time            | Middle Class |         | Other Work Class |         | Strelley |         |
|-----------------|--------------|---------|------------------|---------|----------|---------|
|                 | % > 10       | % > 100 | % > 10           | % > 100 | % > 10   | % > 100 |
| 1 (March 89)    | 14.3         | 9.5     | 12.9             | 0.0     | 38.9     | 0.0     |
| 2 (November 89) | 20.0         | 25.0    | 10.0             | 0.0     | 66.6     | 5.6     |
| 3 (April 90)    | 22.2         | 16.7    | 29.4             | 0.0     | 77.8     | 0.0     |
| 4 (December 90) | 22.2         | 66.7    | 42.9             | 4.1     | 75.0     | 0.0     |
| 1 (April 90)    | 27.9         | 30.2    | 13.1             | 5.3     | 12.5     | 0.0     |
| 2 (December 90) | 20.0         | 65.0    | 42.9             | 7.1     | 83.3     | 0.0     |

Table 12: Percentage of children who could count by fives past 10 and past 100 on four interviewing occasions.

### Limitations of the Study

There are several limitations of this study. In reflection on the interviewing situation, it was evident that some children were frightened by the formal setting. Even though the interviewers tried to make children feel comfortable by speaking quietly and in a slow pace, there were still children who felt ill at ease and this was quite noticeable. It appeared to be more the case with the very youngest children and more often with Aboriginal children than with non-Aboriginal children. We decided to alter the interview setting in 1990 to see if a more informal setting would alter the children's performance. We also interviewed only children who were 6 or more years old. In 1989 we interviewed some children who were just 4 or between 4 and 6 years old and these children were the ones who were more likely to be frightened by the interview. To make the setting more informal, we have drawn on the work of Kearins (1981) where she describes the kind of testing situation she used:

School rooms were not used for testing, for instance: the work was done entirely out of doors, under trees, or in partially enclosed playground sheds or verandahs when shelter was necessary, but always in places open to public view and to natural sights and sounds. Materials were set out at sitting rather than table height, allowing a top view and experimenter and subject sat side by side rather than opposite each other. No time limits were suggested for actual performance and all testing was avoided during school breaks. Causal, quiet behaviour (old clothes, soft voice, limited speech, unhurried movements) and 'appropriate' demeanour for an outsider were maintained throughout. These measures were adopted to accord with both adult expectations of children and general notions of courtesy among desert people, and thus to provide maximum psychological and physical comfort for participants (1981, p439).

In the Strelley communities, even though the interview schedule was translated into Nyangumarta and given by Nyangumarta teachers, there was still some concern about the nature of the Nyangumarta language used in some of the items. To determine if the language used affected the performance of children, in 1990 two different interviewers were used. One was the same as in 1989 who used a more 'formal' Nyangumarta text. The other was the teacher of the children who used a more 'informal' Nyangumarta in her interviewing. We were unable to notice differences in the results between these two teachers; however, this exercise was confounded by using children who were older and had already been interviewed once so that the interviewing situation was already more familiar.

As can be seen in the problems we have identified in the actual interviewing situation, the researchers and the community are jointly learning about the best way to evaluate the introduction of a new mathematics curriculum. We are also learning about ways of improving the curriculum and making it have more meaning for the children in the community. In 1990 several workshops were given which reflected on the questions of the use of mathematics in the community and how the mathematics program can be better related to these uses. In addition we are planning a workshop that will focus on language and mathematics in the Strelley communities. We see these kinds of dialogues with the community as essential ingredients in improving the learning of mathematics for the children of Strelley.

In 1991 we have also decided to use a more 'suitable' comparison group of Aboriginal children. They are children who are currently taught in a government school but are located in a desert community similar to the Strelley community. They will have more similar child-rearing practices and have little contact with urban life. This longitudinal study will continue for at least another two years so that comparisons with other programs can be made and improvements in the Strelley curriculum can be continued. The extent to which the materials and curricula impact upon these differences could not be determined with the study at this early stage.

### Concluding Comments

There are three main conclusions to draw from this study. Firstly, as far as the interview questions used are concerned, there are enormous ranges of mathematical performance within individual schools and across the schools. We were not surprised by these observations.

Secondly, the change in mathematical performance over the course of most of a school year is rather small, reflecting the remark in the Cockcroft Report that mathematics is both difficult to learn and to teach. It is well to be realistic in terms of our expectations over the early years of mathematics.

Thirdly, the comparisons between schools suggest that the Aboriginal children in the remote community do not fall further behind their counterparts in either the middle class or working class schools, but nor do they catch up any of the substantial gap between these groups. Even though we have used rather 'precise' statistics to measure the differences between these groups, we are also aware that these children inhabit significantly different learning environments. These factors have to be taken into consideration when judging the impact of a new mathematics program in a remote Aboriginal community.

**Note 1:** For further information about the reasons why we chose to introduce Montessori and Mortensen mathematics and about the interview schedule construction, contact the author for a paper delivered by Barry Kissane and Marian Kemp at the Mathematics Education Research Group in Australasia 13th Annual Conference, University of Tasmania, Hobart, July 1990.

**Note 2:** The reasons for the changes in the sample numbers are as follows: we began with 97 children for time 1; this was reduced to 68 for time 2; on the 3 time 133 children were interviewed, most for the first time - these latter numbers were added to time 1; by 4th time, 114 children were interviewed, some for the 4th time and most for the second time. Altogether 162 children were interviewed once; 143 interviewed twice; 42 interviewed three times and 39 interviewed four times.

**Note 3:** This report is the result of a joint project between the Strelley Community and its Aboriginal Independent Schools and the School of Education at Murdoch University. A team of researchers at Murdoch University (including Jan Currie, Barry Kissane, Marian Kemp, Beth Powell, Ann Chapman and Harriett Pears) has been involved in this research and program development since 1984. Many teachers and individuals have been involved in the project from the Strelley Communities as translators (Monty Hale, Fred Bradman, Gwen Bucknall), as interviewers (Fred Bradman, Lolla Walker and Gwen Bucknall) and as teachers (Angelena Handley, Selina Mick and Mary Ellen Hawks). The Principals and the Community have provided hospitality and communicated their genuine interest in the project. Ray Butler of the Nomads Charitable and Educational Foundation has given advice and guided the project through its many stages.

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## REFERENCES

- Brod, R L (1979) *Choctaw Education*. LPS & Associates, Rocky Boy's Route, Box Elder, MT 59521, December.
- Bucknall, J and Bucknall, G (1988) *Review of Aboriginal Independent Schools, Western Australia*, Prepared for the Review of Aboriginal Independent Schools' Steering Committee, Broome: Ngurnipali Ngurnarri: Aboriginal Education Consultants.
- Butler, S R and Marsh, H W (1986) "Reading and Arithmetic Achievement in Primary Years for Students from Non-English Speaking Families: A Seven-Year Longitudinal Comparison", *Australian Journal of Education*, 30 (1), 23-44.
- Cockcroft, W. H (1982) *Mathematics Counts*, London: HMSO.
- Cocking, R R and Chipman S (1988) "Conceptual Issues related to Mathematics Achievement of Language Minority Children", In Cocking R R and Mestre J P (Eds) *Linguistic and Cultural Influences on Learning Mathematics*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Cocking R R and Mestre J P (Eds) (1988) *Linguistic and Cultural Influences on Learning Mathematics*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Coombs, L M (1970) *The Educational Disadvantage of the American Indian Student*. Las Cruces, New Mexico: New Mexico State University.
- Cheek, H N (1984) "A Suggested Research Map for Native American Mathematics Education", *Journal of American Indian Education*, 23 (2) January, 1-9.
- Cuevas, G (1984) "Mathematics Learning in English as a Second Language", *Journal for Research in Mathematics Education*, 15 (2), 134-144.
- Currie, J, Kissane, B, Kemp, M and Pears, H (1990) "Improving Mathematics of Aboriginal Children in a Remote Community: Interview Results 1989". Unpublished paper, Murdoch University.
- Dawe, L (1983) "The Development of Inquiry Skills in Mathematics and Science: Problems for the Bilingual Child", in D Blane (Ed) *The Essentials of Mathematics Education*. Melbourne: Mathematics Association of Victoria.

- De Lacey, P R (1970) "A Cross-Cultural Study of Classificatory Ability in Australia", *Journal of Cross-Cultural Psychology*, 1 (4), 293-304.
- De Lacey, P R (1971) "Verbal Intelligence, Operational Thinking and Environment in Part-Aboriginal Children", *Australian Journal of Psychology*, 23 (2), 145-49.
- De Lemos, M (1969) "The Development of Conservation in Aboriginal Children", *International Journal of Psychology*, 4 (4), 255-69.
- Graham, B (1984) "Finding Meaning in Maths: An Introductory Program for Aboriginal Children", *The Aboriginal Child at School*, 12 (4), 24-39.
- Graham, B (1988) "Mathematical Education and Aboriginal Children", *Educational Studies in Mathematics*, 19, 119-135.
- Hedges, L V and Stodolsky, S S (1987) *A Formative Evaluation of Kindergarten Everyday Mathematics*. Chicago: University of Chicago School Mathematics Project.
- Hedges, L V, Stodolsky, S S and Mathison S (1988) *A Follow-up of Kindergarten Everyday Mathematics Users*. Chicago: University of Chicago School Mathematics Project.
- Hunting, R & Whitely, H (1983) "Mathematics, Prior Knowledge and the Australian Aborigine", *Research in Mathematics Education in Australia*, MERGA, 3-24.
- Kearins, J (1976) "Skills of Desert Aboriginal Children", In G E Kearney and D W McElwain (Eds.), *Aboriginal Cognition in Tertiary Education: A Framework for the 1985-87 Triennium*. Woden, ACT: AGPS.
- Kearins, J (1981) "Visual Spatial Memory in Australian Aboriginal Children of Desert Regions", *Cognitive Psychology*, 13, 434-460.
- Leap, W L (1988) "Assumptions and Strategies Guiding Mathematics Problem Solving by Ute Indian Students", In Cocking R R and Mestre J P (Eds) *Linguistic and Cultural Influences on Learning Mathematics*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Myers, D E and Milne A M (1988) "Effects of Home Language and Primary Language on Mathematics Achievement: A Model and Results of Secondary Analysis", In Cocking R R and Mestre J P (Eds) *Linguistic and Cultural Influences on Learning Mathematics*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Schindler, D E and Davison D M (1985) "Language, Culture and the Mathematics Concepts of American Indian Learners", *Journal of American Indian Education*, 24 (3), 27-34.
- Scott, P B (1983) "Mathematics Achievement Test Scores of American Indian and Anglo Students: A Comparison", *Journal of American Indian Education*, 22, 3 (May), 17-19.
- Seagrim, G and Lendon, R (1980) *Furnishing the Mind: A Comparative Study of Cognitive Development in Central Australian Aborigines*. New York: Academic Press.
- Stigler, J W, Lee S and Stevenson, H W (1987) "Mathematics Classrooms in Japan, Taiwan, and the United States", *Child Development*, 58, 1272-1285.
- United States Senate, Special Subcommittee on Indian Education. *Indian Education: A National Tragedy--a National Challenge*. Washington, D.C.: U S Government Printing Office, 1969.
- Watson, H (1987) "Learning to Apply Numbers to Nature", *Educational Studies in Mathematics*, 18, 339-357.
- Wright, B. D. & Stone, M. H. (1979) *Best Test Design*. Chicago: MESA Press.